

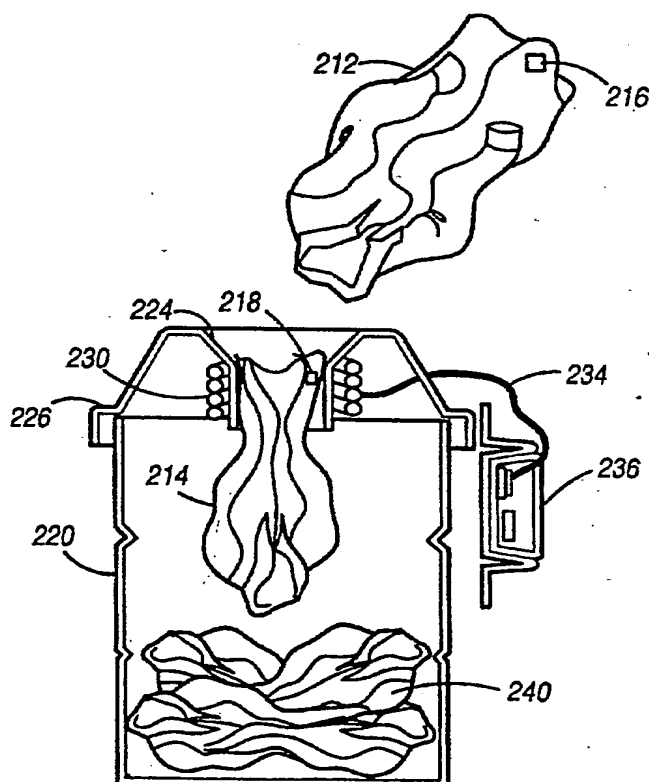
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/US96/07404</p> <p>(22) International Filing Date: 21 May 1996 (21.05.96)</p> <p>(30) Priority Data: 08/477,716 7 June 1995 (07.06.95) US</p> <p>(71) Applicant: MOTOROLA INC. [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).</p> <p>(72) Inventors: EBERHARDT, Noel, Henry; 21407 Krzich Place, Cupertino, CA 95014 (US). STRAUSS, David, Peter; 45 Kensington Court, Kensington, CA 94707 (US). WALKER, Russel, Earl; 1203 Lynbrook Way, San Jose, CA 95129 (US).</p> <p>(74) Agents: CUNNINGHAM, Gary, J. et al.; Motorola Inc., Intellectual Property Dept., 1303 East Algonquin Road, Schaumburg, IL 60196 (US).</p>		<p>(81) Designated States: AU, CA, CN, JP, NZ, RU, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

**(54) Title: AUTOMATICALLY IDENTIFYING OBJECTS DEPOSITED IN A CONTAINER****(57) Abstract**

A system for automatically identifying objects (212, 214) deposited in an area, such as a container, sack, conveyor, or a pile. Each object is affixed with a tag (216, 218). The tag (216, 218) has an individual identifying code and is capable of transmitting a signal encoded with the identifying code upon receiving an interrogation signal. The system also includes a container (220) having an opening funnel (224) for allowing objects to deposited into the container (220). An antenna assembly (230) having a shape in conformity with the shape of the opening is mounted on the opening. A tag reader (236) is positioned outside the container (220). The reader (236) contains electronic circuits to generate the interrogation signal (which could provide power to the tag) and receive the encoded signal from the tag.



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## AUTOMATICALLY IDENTIFYING OBJECTS DEPOSITED IN A CONTAINER

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BACKGROUND OF THE INVENTIONField of the Invention

10 The invention relates to a system for automatically identifying objects, and more particularly, to a system which associates an identification code to each object and automatically identifies and records the codes when the objects are deposited into a container.

Background

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In many industrial processes, it is desirable to apply a processing step to objects from different sources, and after the processing, return the objects to their sources. Thus, it is important to develop a system which can easily identify these objects as they pass through the processing step. An example is 20 commercial garment cleaning in the laundry industry. Soiled garments are collected by various industrial customers from individual customers. The collection or delivery trucks send the soiled garments to a central laundry facility, which groups the garments into batches according to the types of cleaning operations. Each batch may contain garments collected by some or all 25 of these industrial customers. After these garments are cleaned, they are sorted out and returned to the original customers. Thus, it is desirable to have a system that can keep track of the origin of these garments.

FIG. 1 shows a prior art system which can be used for such purposes. A tag 102 is attached to an object 104. The tag is capable of transmitting a signal 30 encoded with a distinct identifying code upon activated by an interrogating signal. The electromagnetic interrogation signal is being transmitted by a radio frequency identification (RFID) reader 108 on activation of a trigger switch (or similar devices). In this embodiment, RFID reader 108 is an integral part of a

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portable data terminal 110. Terminal 110 could also be a portable computer or a radio data terminal. Reader 108 contains an antenna 106 which transmits the interrogation signal generated by a RF circuit (not shown) inside reader 108. Terminal 110 typically also contains a keypad 112 and a display means 114.

5 When tag 102 is in close proximity with reader 108, the interrogation signal activates an electronic circuit insider tag 102. The electronic circuit generates and transmits the encoded signal. Reader 108 also contains a receiver circuit which is able to receive the encoded signal and a decoder circuit for recovering the identifying code from the encoded signal. The identifying code is then sent to

10 portable data terminal 110 for display at display means 114. Terminal 110 typically contains memory which is able to store the identifying code for later uses (e.g., "down load" the code to a computer). The keypad 112 can be used to enter other information, such as a batch number.

Tags having different identifying codes are attached to different objects.

15 By reading and recording these identifying codes as objects pass through different processing steps, it is possible to keep track of the whereabouts of these objects.

In such a system, the interrogating or activating signal is conventionally a signal of a predetermined frequency which is inductively coupled to the tag by

20 means of an electromagnetic coupling arrangement which supplies power to the tag. The tag, in turn, continuously produces its unique identifying signal for as long as it is activated, and transmits same back to the receiver by modulating a carrier with the coded information signal, using methods such as FSK (frequency shift keying) or PSK (phase shift keying). The output signal of the tag is in turn

25 electrically coupled to the receiver either by means of a magnetic field, an electrostatic field or simultaneously by both a magnetic or electrostatic field.

FIG. 2 shows another prior art system. The components in FIG. 2 which perform similar function as the components in FIG. 1 have identical reference numerals. The RFID reader in FIG. 2 can be detached from the

30 portable data terminal while the reader in FIG. 1 is an integral extension of the portable data terminal.

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In the systems of FIGs. 1 and 2, an operator has to hold the tag 102 close to the reader 108 so that there is sufficient electromagnetic coupling between tag 102 and reader 108 in order to identify and record the code of tag 102. The operator then deposits the object and the attached tag to a container. Typically, this operation is slow because it involves two separate steps (i.e., recording and depositing). Sometimes, the operator may forget to deposit an identified and recorded object in the container, or deposit in the container an object not yet identified and recorded. Thus, the operation is error prone.

#### 10 Summary of the Invention

The present invention relates to a system for automatically identifying objects deposited in an area, such as a container, sack, conveyor, or a pile. Each object is affixed with a tag. The tag has an individual identifying code and is capable of transmitting signals encoded with the identifying code upon receiving an interrogation signal. The system also includes a container having an opening for allowing objects to be deposited into the container. An antenna having a shape in conformity with the shape of the opening is mounted on the opening. A tag reader is positioned outside the container. The tag reader can be battery or mains powered. The reader contains electronic circuits to generate the interrogation signal (which could provide power to the tag) and receive the encoded signal from the tag. The reader is electrically coupled to the antenna. When objects are deposited into the container through the opening, the readers can receive the encoded signal and recover the identifying codes associated with the objects. In one embodiment of the present invention, the reader can be coupled to a battery powered portable data terminal. The identification code can be recorded in memory and displayed by the portable data terminal. In another embodiment of the present invention, the reader generates an audio and/or visual signal when a valid identifying code is detected. In yet another embodiment of the present invention, the container and the reader can be placed on a hand truck so that they can be conveniently moved to different locations.

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The above system allows an operator to perform only one step (i.e., depositing), and the recording of the identifying code is performed automatically. Consequently, efficiency improves. Further, the above system reduces the possibility of errors because only objects which actually pass through the opening and deposited in the container are recorded.

These and other features and advantages of the present invention are described by the following detailed description of the preferred embodiments together with the accompanying drawings.

#### 10 Brief Description of the Drawings

FIG. 1 shows a prior art object identification system.

FIG. 2 shows another prior art object identification system.

FIG. 3 is an object identification system in accordance with the present invention.

FIG. 4 shows a schematic diagram of a tag and an interrogator/reader in accordance with the present invention.

FIG. 5 shows the structure of an antenna assembly and reader electronic assembly of the present invention.

FIGs. 6A and 6B show an embodiment of the present invention in the form of a hand truck and container assembly.

FIGs. 7A-C show another embodiment of a hand truck and container assembly.

FIG. 8 shows an embodiment of the present invention in which a hood is attached to a fixed structure.

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FIG. 9 shows an embodiment of the present invention in which a hood is placed above a conveyor.

5     Detailed Description of the Preferred Embodiment

10     The present invention comprises a novel automatic object identifying system. The following description is presented to enable any person skilled in the art to make and use the invention. Descriptions of specific applications are provided only as examples. Various modifications to the preferred embodiments will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown, but is to be  
15     accorded the widest scope consistent with the principles and features disclosed herein.

20     FIG. 3 shows a system in accordance with the present invention. Each object, such as garments 212 and 214, is affixed with a tag, e.g., 216 and 218. The garments are deposited into a container 220 through a funnel 224 of a hood 226. Alternatively, the garments can be deposited in a sack or on a conveyor. An antenna assembly 230 is mounted to the neck of funnel 224. Antenna assembly 230 is coupled to a RFID reader electronic assembly 236 through a connecting cable 234. Reader assembly 236 and antenna assembly 230 decoded identifying codes can be transferred to a portable data terminal (not shown).  
25     FIG. 3 also indicates that other soiled garments 240 have already been deposited into container 220.

30     A circuit schematic diagram 1 of a tag and a reader is shown in FIG. 4. The reference numeral 5 designates the circuitry of an exemplary interrogator and receiver disposed in reader electronic assembly 236. Reference numeral 9 designates an exemplary circuitry of a tag, such as tag 218. Reference numeral 7 designates physical material separating tag 9 from interrogator and receiver 5.

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This material could be a combination of materials from funnel 224 and garment 214 of FIG. 3.

The interrogator circuit, which likewise functions as a power supply to tag 9, consists of an oscillator 11, which puts out power at a convenient  
5 frequency  $f_0$ , e.g. 400 or 125 kHz, and which is connected to a primary transmit coil antenna 13 tuned to resonate at the output frequency of oscillator 11 by means of a capacitor 15. A secondary coil antenna 74 and a resonating capacitor 75 is also used. Coils 13 and 74 emit a strong electromagnetic field. Coils 13 and 74 are part of the antenna assembly 230 and may not be disposed inside reader  
10 assembly 236.

Tag 9 includes a receive antenna or coil 17 and a parallel connected capacitor 19 which form a tuned LC circuit which is resonant at the frequency  $f_0$  of the oscillator 11. A full wave rectifier circuit 21 and a filter capacitor 23, which are connected to antenna coil 17 and capacitor 19, provide power for the  
15 remaining circuitry of the tag 9 through lines 25 and 27, the connections of which are not shown for simplicity. One side of the receiving coil antenna 17 is connected via a line 29 to the input of a frequency dividing counter 31 as a clock signal  $f_0$ . The frequency dividing counter 31 produces an R.F. signal of frequency  $f_0/2$  on line 33 and address signals on a plurality of memory select  
20 lines, only two of which have been shown at 35 and 37, for activating a read only memory (ROM) 39, which provides a coded identifying signal comprised of a plurality of binary pulses on an output line 41. The counter 31 provides timing so that the content of the ROM 39 outputs encoded data so long as the continuous interrogator signal produced by the exciter or interrogator circuit 11,  
25 13, 15 is being received. Lines 33 and 41 are connected to respective inputs of an exclusive OR-gate 43 which produces output pulses on a line 45 which are fed to an electrostatic or electric field antenna 47 which may, for example, be a capacitor plate which may be a length of wire. The coded pulses on line 41 occur at a much lower rate than the signal of frequency  $f_0/2$  on line 33. The  
30 effect of exclusive OR-gate 43 is to bi-phase modulate the signal on line 33, which serves as a carrier frequency signal, with the coded pulse train on line 41,



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as described in greater detail in U.S. Pat. No. 4,818,855, the subject matter of which is incorporated herein by reference.

In the illustrated embodiment the line 45 is likewise connected to the gate 48 of an MOS transistor 49, for example an N channel enhancement mode transistor, having its drain 50 connected to a resistor 71. Resistor 71 is connected to an end 72 of capacitor 19. The source 51 of transistor 49 is connected to ground. With this arrangement, the coded data on line 45 is simultaneously coupled to the receiving antenna coil 17 which then likewise acts as an electromagnetic transmitting coil or antenna.

The signals on line 45 fed to the electrostatic or electric field antenna 47 and to the antenna or coil 17 are picked up respectively at the interrogator/reader 5 by a receiving electrostatic antenna 52, and/or a receiving electromagnetic antenna or coil 53, which are connected to, the input of a common preamplifier circuit 55. Antennas 52 and 53 are typically not disposed in reader assembly 236, although they could be disposed therein. The output signals from the preamplifier 55 are detected by a demodulation circuit 57 and passed to a decoder 59 for validation. Demodulation circuit 57 and decoder 59 recover the data stored in ROM 39 (which have been modulated by gate 43). When a correctly coded signal has been detected, data is output to an operating device 61. Operating device 61 corresponds to a portable data terminal or means for generating audio and/or visual signals, and is not disposed in reader assembly 236 (with the possible exception of the means for generating audio and/or visual signals). It should be noted, however, that although tag 9 of the illustrated system utilizes both electromagnetic coupling and electrostatic coupling for simultaneous transmission of an encoded identification signal to the reader portion of the interrogator/reader 5, such is not required. That is, if desired only electrostatic coupling or only electromagnetic coupling may be utilized in a known manner.

It should be appreciated that the circuitry shown in FIG. 4 is one of many circuits which could be used for a tag and a RFID reader. Other circuits which provide similar functions could be used.

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Many types of identification codes can be used. One type of code format is described in U.S. Pat. No. 5,382,952, issued to Miller and entitled "Transponder for Proximity Identification System," the disclosure of which is incorporated herein by reference. Another type of code format is described in a  
5 copending U.S. patent application Serial No. XXXXXX filed May 1, 1995 by Bierach and Shi, entitled "Communication Data Format," the disclosure of which is incorporated herein by reference.

FIG. 5 shows an antenna assembly 302 connected to a RFID reader electronic assembly 304 through a cable 306. Reader assembly 304 is in turn  
10 connected to a portable data terminal (or alternatively, a portable computer or a radio data terminal) 310 through a cable 312. Antenna assembly 302 comprises a primary coil 316 sandwiched between a pair of secondary coils 318. In one embodiment of the present invention, primary coil 316 has 8 turns and secondary coils 318 consist of two 25 turns coils. Primary coil 316 and  
15 secondary coil 318 correspond to coils 13 and 74, respectively, in FIG. 4. Reader electronic assembly 304 contains a battery 324, preferably a gel cell, and an electronic portion 322 which corresponds to the circuit indicated by reference numeral 5 of FIG. 4. Assembly 304 also includes a door 328 which provides easy access to battery 324 and electronic portion 322.

20 Portable data terminal 310 can be used to store the identifying codes received by reader assembly 304. After all the garments have been deposited in the container, the codes stored in portable data terminal 310 can be transferred to a host computer for further processing.

FIG. 6A shows an embodiment of the present invention in the form of a  
25 hand truck and container assembly 350. Assembly 350 includes a barrel 354 fitted with a hood 351. Hood 351 contains a funnel 352 which facilitates the deposition of objects inside barrel 354. An antenna assembly (not shown) is mounted on the inside of funnel 352. Barrel 354 is held on a hand truck 356. FIG. 6B shows the detail structure of hand truck 356. It contains a RFID reader  
30 electronic assembly 360, wheels 362 and 364, and holding structures 366 and 368. The reader assembly 360 can be coupled to the antenna assembly using a

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cable (not shown). Wheels 362 and 364 allow hand truck and container assembly 350 to be easily moved to a desired location.

FIG. 7A shows a modification of the embodiment shown in FIGs. 6A and 6B. In this embodiment, a barrel strap 404 is mounted on a hand truck 406.

5 Barrel strap 404 securely attaches a barrel 408 to hand truck 406.

FIG. 7B shows the details of the system shown in FIG. 7A.

Components in FIG. 7B which are similar to that of FIG. 7A have the same reference numerals. Hand truck 406 contains a set of wheels 412 and 414, in addition to barrel strap 408. A RFID reader electronic assembly 420 can be  
10 attached to hand truck 406. An antenna 422 is mounted on the funnel 426 of a hood 424. Antenna 422 can be coupled to reader electronic assembly 420 using a cable 430.

FIG. 7C shows additional details of reader electronic assembly 420. A battery 450, such as gel cell, and reader electronic circuit 452 can be mounted  
15 inside a housing 440. Housing 440 has a socket 442 to allow a DC adaptor (not shown) be connected to and charge battery 450. Assembly 420 also includes a cover 460 which can be mounted to housing 440 by using screws 462-465.

FIG. 8 shows another embodiment of the present invention. In this embodiment, a hood 502 containing an antenna (not shown) can be mounted to a  
20 fixed structure, such as a wall 504, using attachment tool 506. A barrel 510 can be positioned directly below hood 502 on a floor or other supporting platform. A RFID reader electronic assembly (not shown) can be mounted on a convenient place.

FIG. 9 shows another embodiment of the present invention in which a  
25 hood 522 containing an antenna (not shown) is placed above a conveyor 523. Objects with tags attached can pass through hood 522 and carried by conveyor 523.

The above embodiments show that the hood can be detached to the barrel. This arrangement is designed to allow the same hood be used with  
30 different barrels. It is possible for the hood to be fit integrally on a barrel and be readily removable. Similarly, the funnel in the hood is designed to facilitate the

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deposition of objects. Other shapes and forms of openings can also be used. In addition, the RFID reader assembly can be placed in many locations.

The invention now being fully described. It will be apparent to one of ordinary skill in the art that any changes and modifications can be made thereto  
5 without departing from the spirit and scope of the invention as set forth in the claims below.

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## IN THE CLAIMS:

5 We claim:

1. A system for automatically identifying objects deposited in an area, comprising:  
a set of tags, each tag having an identifying code and being attached to one  
10 of said objects, each tag capable of transmitting a signal encoded with said identifying code upon receiving an interrogation signal;  
an opening for allowing said objects and their attached tags to be deposited in said area;  
an antenna mounted to said opening and having a shape conformal  
15 therewith; and  
a reader coupled to said antenna for transmitting said interrogation signal, said reader containing circuits for receiving said encoded signal.
2. The system of claim 1 wherein said area is enclosed by a  
20 container.
3. The system of claim 2 wherein said container further comprises:  
a barrel for containing said objects; and  
a hood having a funnel for allowing said objects to be deposited  
25 into said barrel; and  
wherein said antenna is mounted on said funnel.
4. The system of claim 3 further comprising means for attaching said  
hood to a fixed structure.  
30
5. The system of claim 1 further comprising a portable data terminal for recording said identifying codes which are decoded by said reader.

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6. The system of claim 1 wherein said data terminal is a radio data terminal.

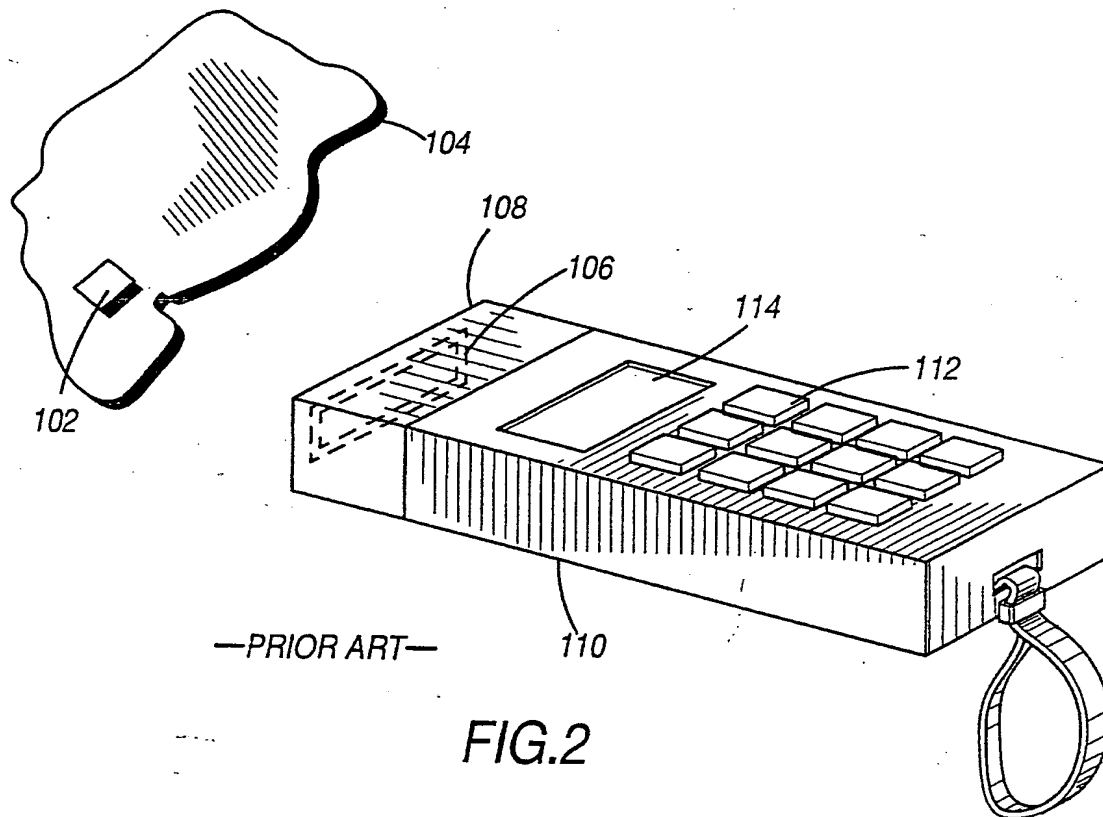
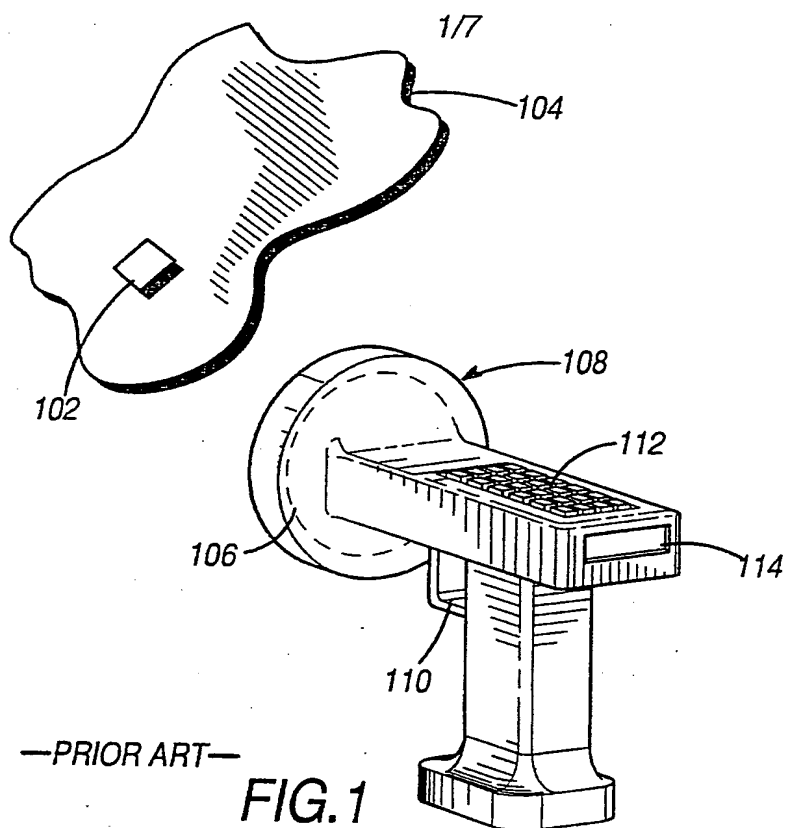
5 7. The system of claim 1 further comprising a portable computer for recording said identifying codes which are decoded by said reader.

8. The system of claim 1 further comprising means for generating a feedback signal when a decoded signal contains a valid identifying code, said feedback signal is at least one of an audio signal and a visual signal.

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9. The system of claim 1 wherein said area is enclosed by a sack.

10. The system of claim 1 further comprising a conveyor positioned below said opening.



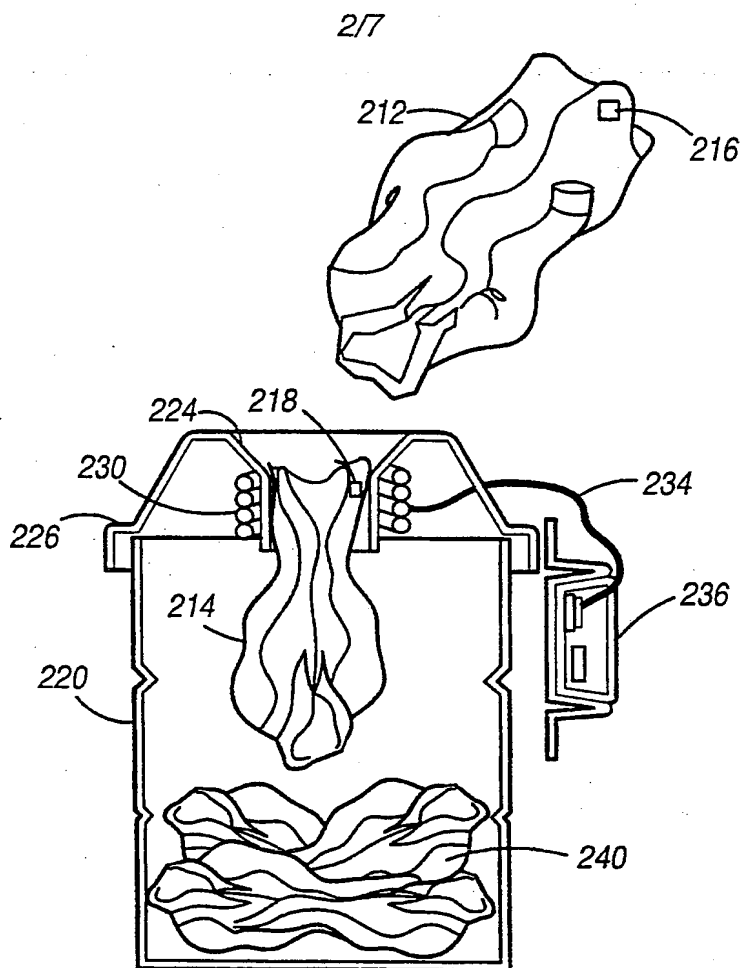


FIG. 3

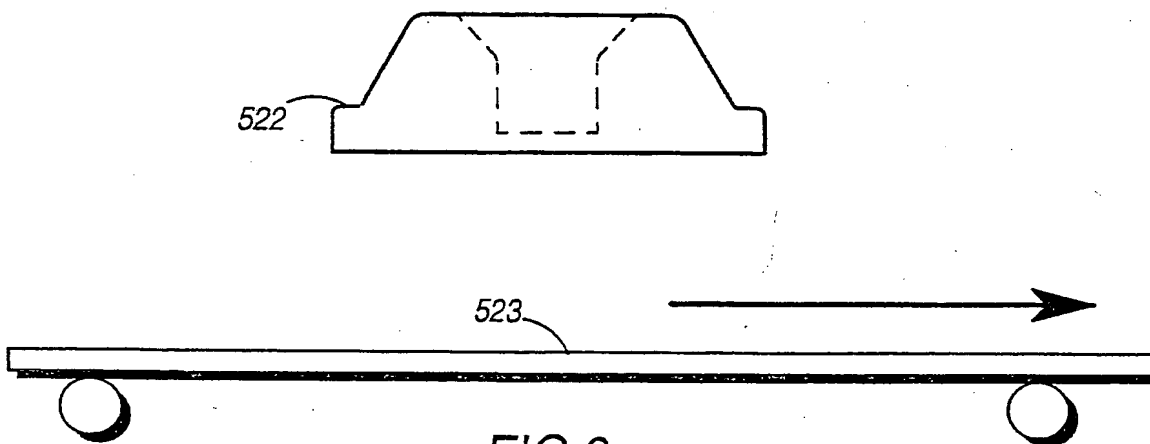


FIG. 9



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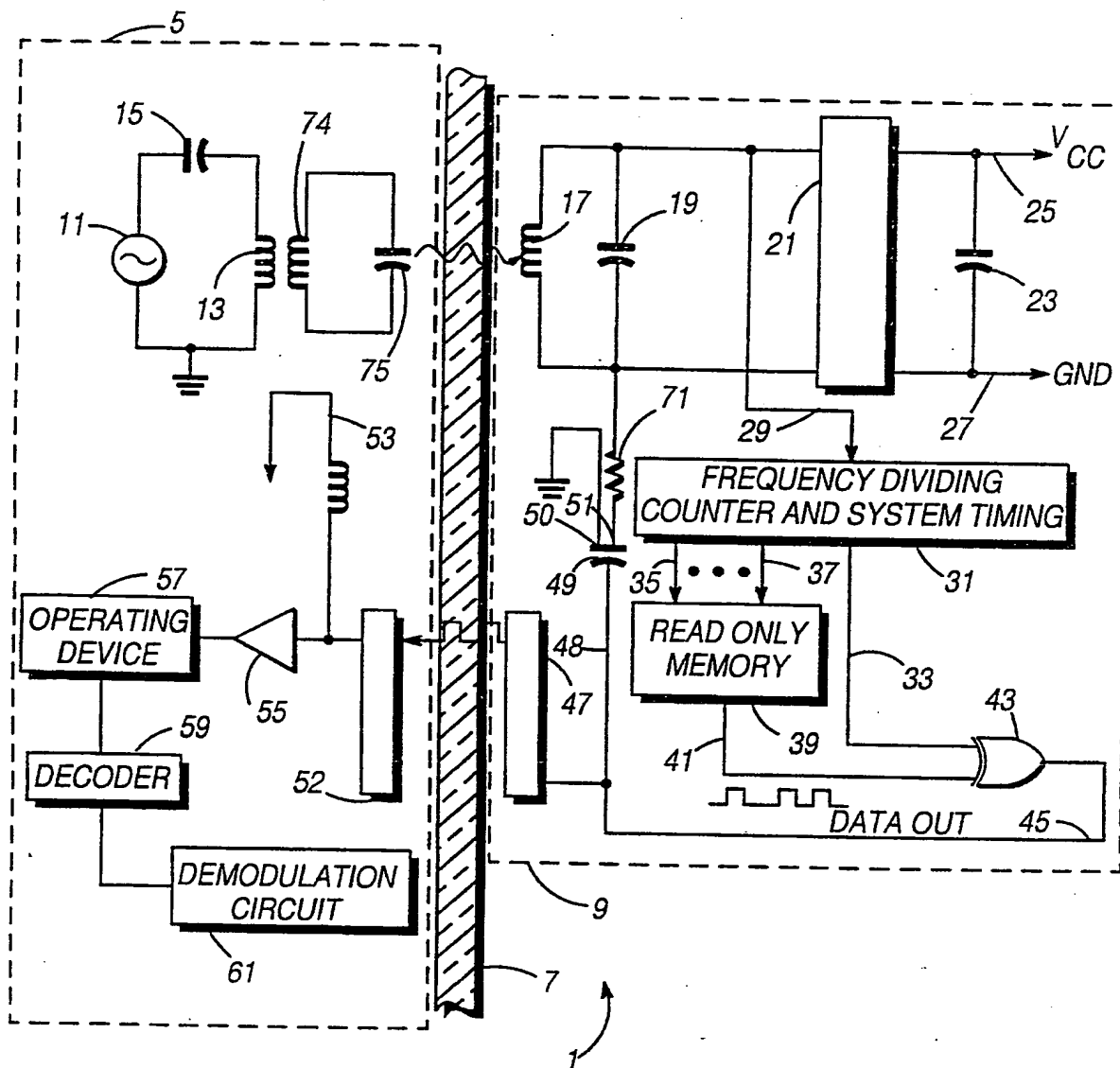
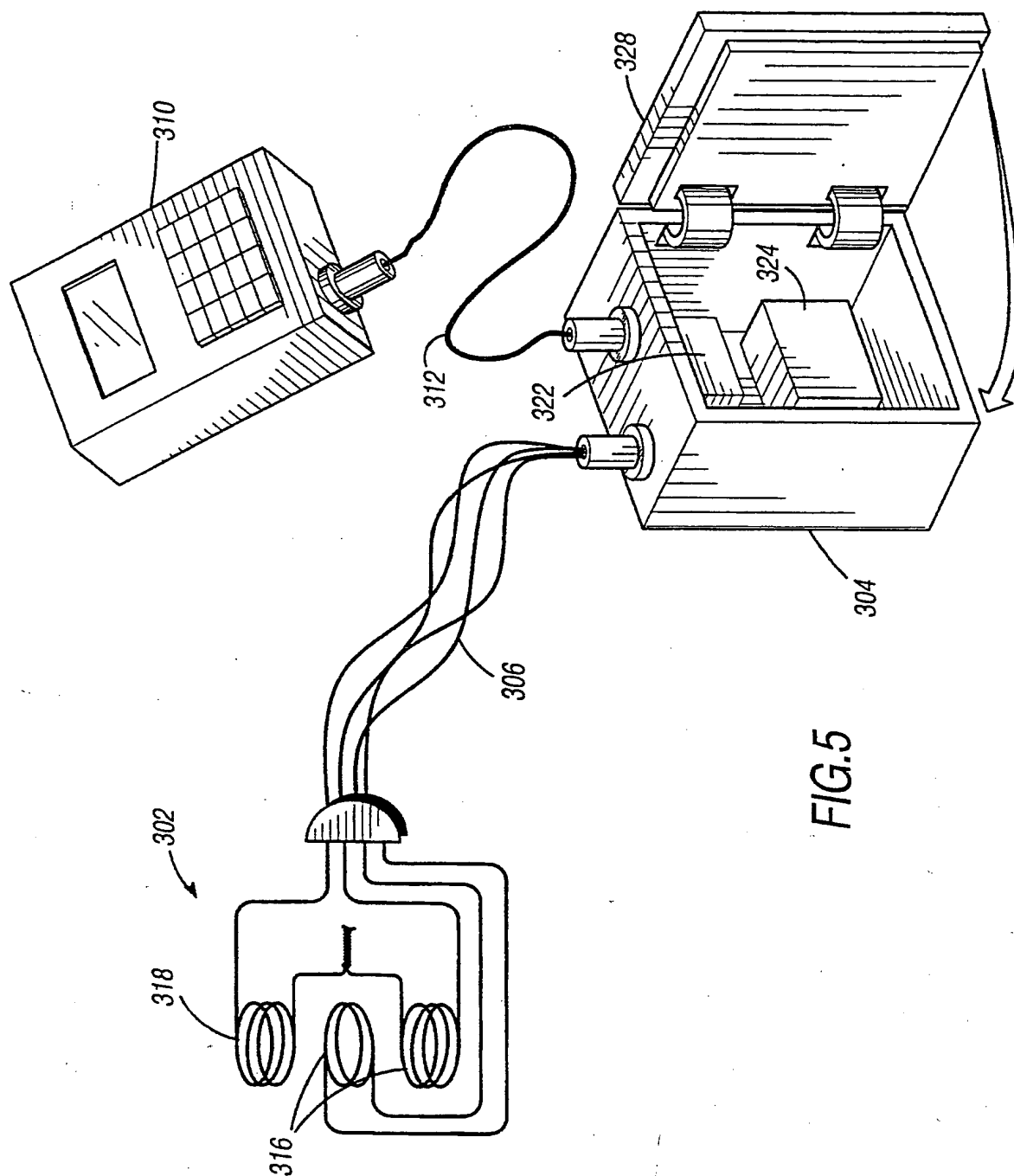
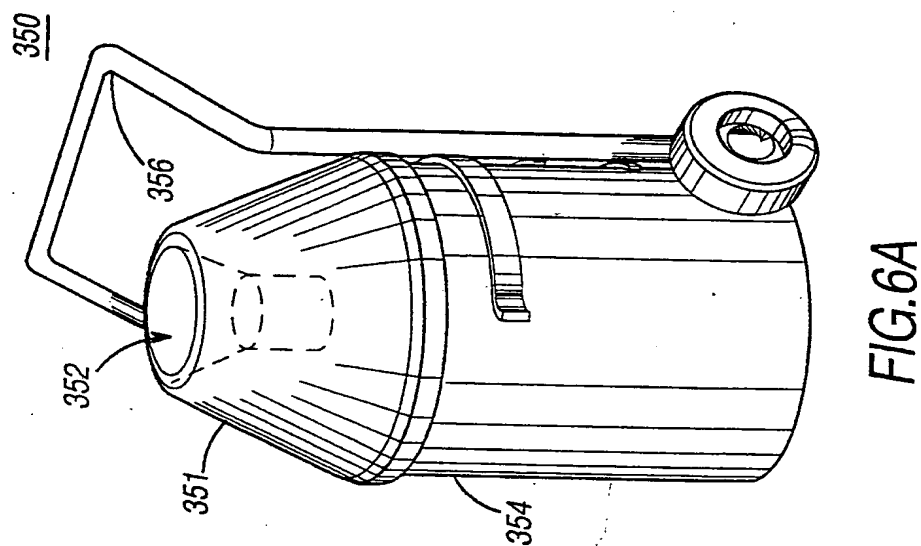
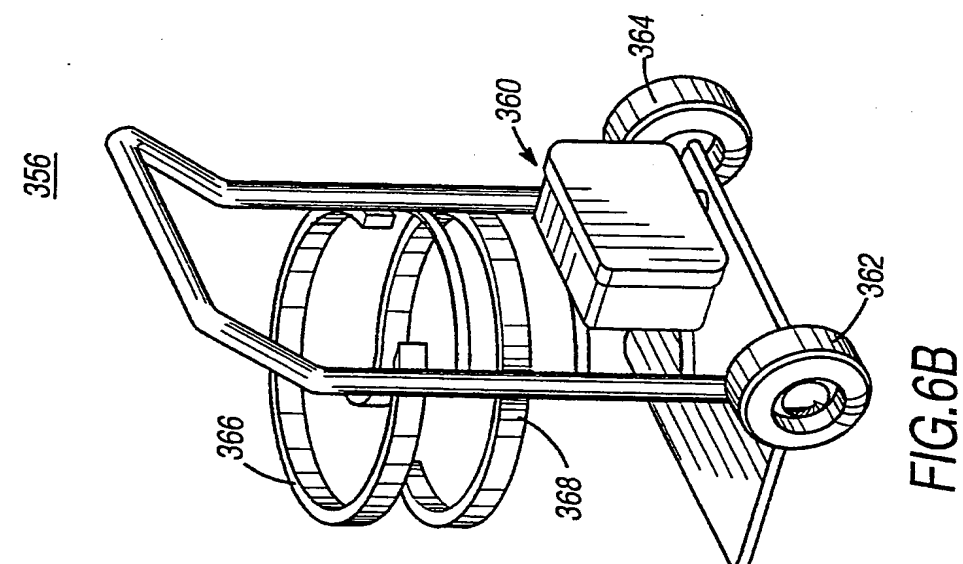
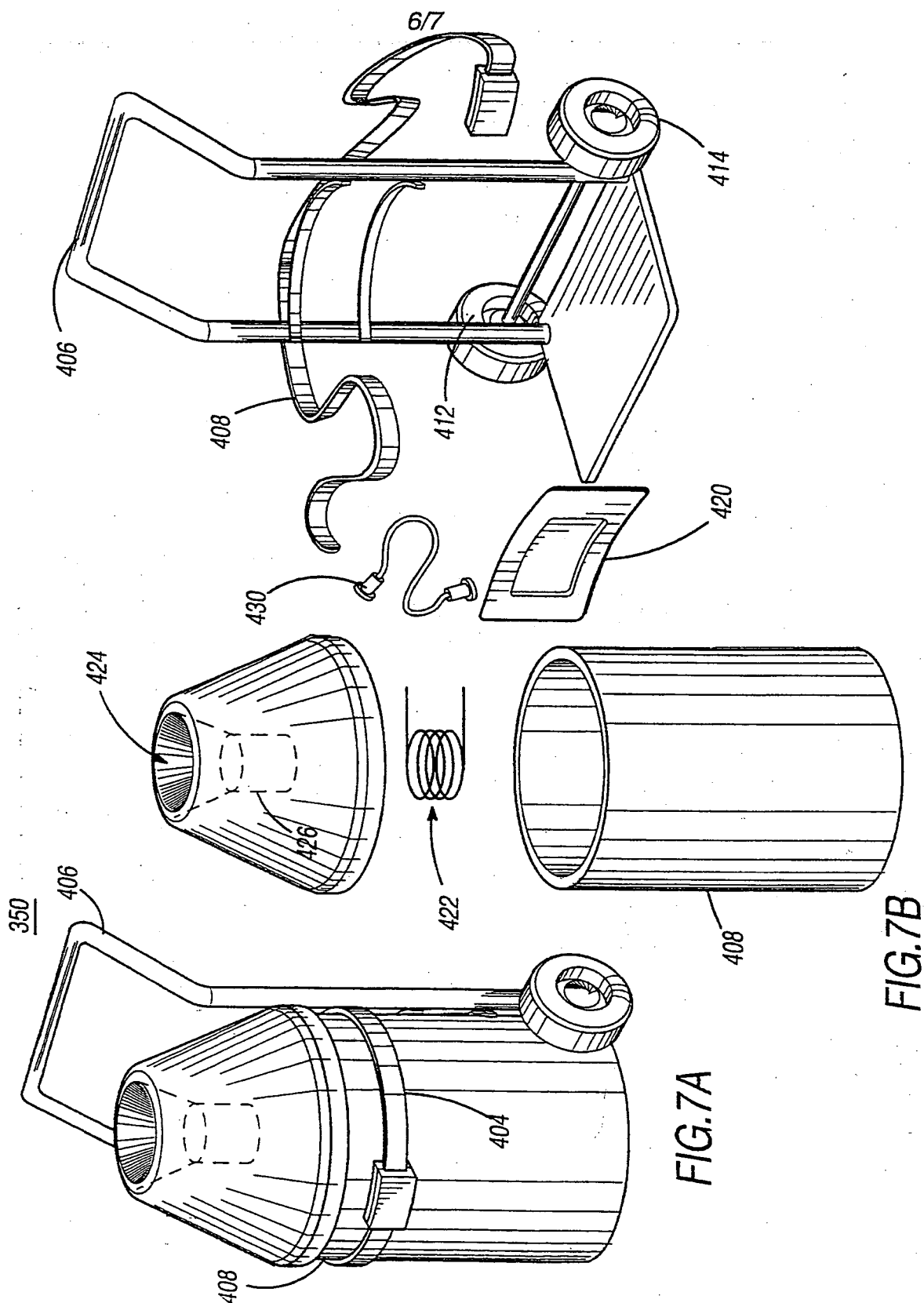


FIG.4

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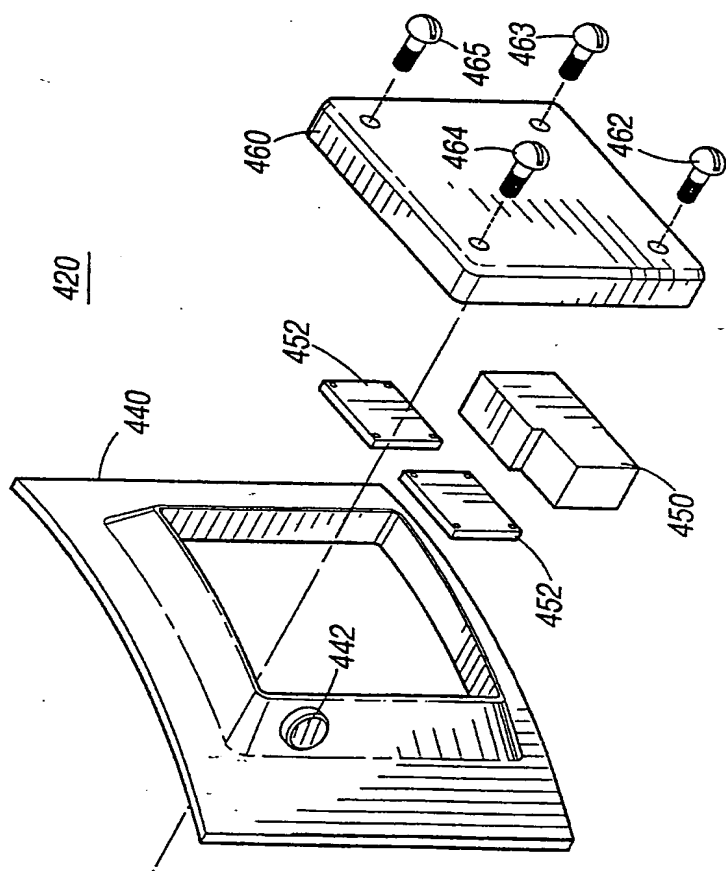


FIG. 7C

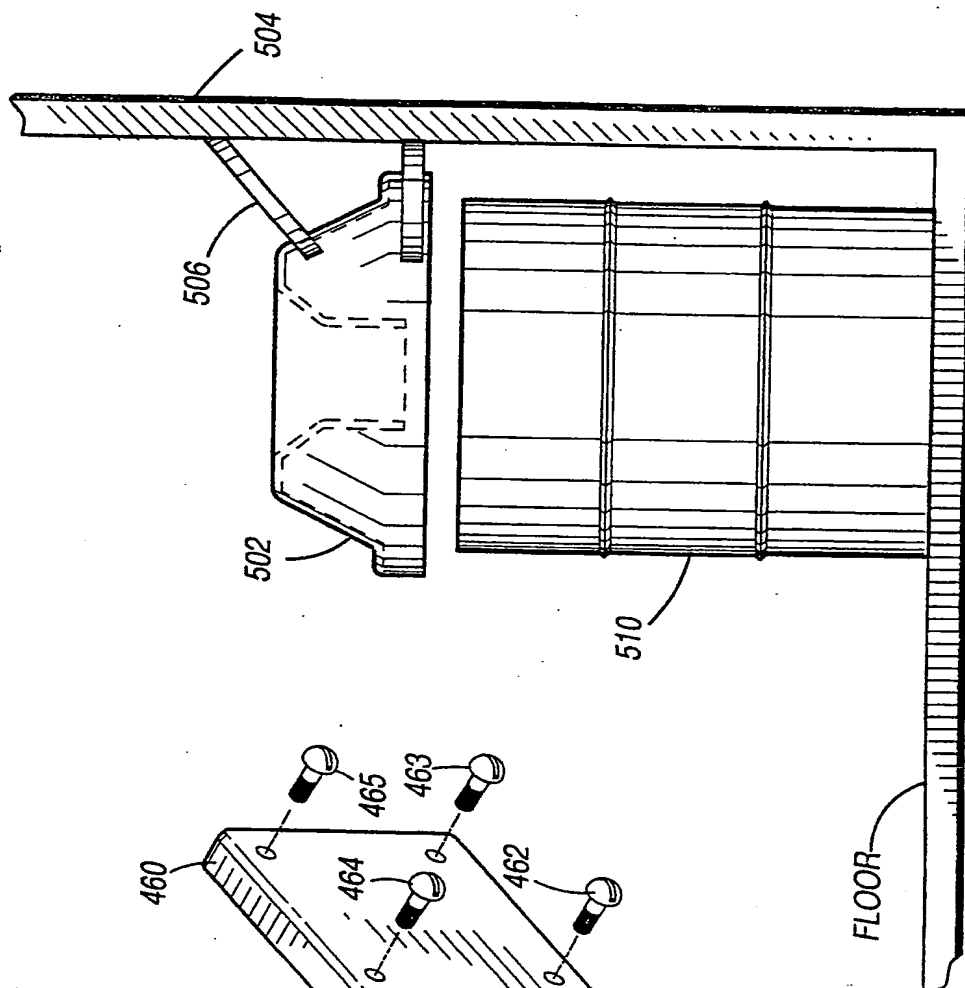


FIG. 8

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/07404

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :G06K 7/00  
US CL :340/825.540

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/825.35, 825.54, 825.31, 825.72, 825.540, 572, 870.32; 343/867; 235/449, 450; 8/137, 142

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,656,463 (ANDERS ET AL.) 07 April 1987, Figs. 5 and 7--col. 7, line 64 - col. 10, line 21; and col. 26, line 8 - col. 27, line 22.	1-10
Y	US, A, 5,095, 309 (TROYK ET AL.) 10 March 1992, entire document.	1-10
Y	US, A, 5,382,952 (MILLER) 17 January 1995, entire document.	1, 5, 6, 8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search

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